Neuropsychologia, Vol. 28, No. 4, pp. 375–383, 1990.
Printed in Great Britain.

0028-3932/90 $3.00 + 0.00
Pergamon Press plc

APPRECIATION OF METAPHORIC ALTERNATIVE WORD MEANINGS BY LEFT AND RIGHT BRAIN-DAMAGED PATIENTS

HIRAM H. BROWNELL,*†‡|| TRACY L. SIMPSON,†‡ AMY M. BIHRLE,†‡ HEATHER H. POTTER†‡ and HOWARD GARDNER†‡§

*Boston College, †Boston Veterans Administration Medical Center, ‡Aphasia Research Center, Department of Neurology, Boston University Medical School and §Harvard Project Zero

(*Received* 14 *June* 1988; *accepted* 14 *November* 1989)

Abstract—Appreciation of metaphoric and nonmetaphoric alternative word meaings was assessed in 19 aphasic, left (LHD) and 15 non-aphasic, right (RHD) hemisphere brain-damaged stroke patients. With the one exception in the aphasic group, all patients were male. In an unspeeded sorting task, subjects responded on the basis of less frequent, alternative meanings of polysemous target words. Targets were either polysemous adjectives (e.g. "warm") having metaphoric alternative meanings (loving) or polysemous nouns (e.g., "pen") having non-metaphoric alternative meanings (writing implement, cage). Both patient groups peformed worse overall than a group of nonbrain-damaged control subjects. Relative to the RHD patients, LHD patients showed a spared appreciation of metaphoric alternative meanings. In addition, LHD, but not RHD, patients performed better on metaphoric adjective trials when there was high similarity between a word's dominant and (metaphoric) alternative meaning. The results suggest a pervasive insensitivity of RHD patients to alternative interpetations of linguistic units, and a special role for the intact right hemisphere in lexical-semantic processes related to metaphor comprehension.

INTRODUCTION

BOTH the left and right cerebral hemispheres play important, though different roles in successful communication. The study of aphasia subsequent to left-sided brain damage has helped reveal the crucial role of the left hemisphere in many aspects of language ability [1]. Less is known about the contribution of the right hemisphere to different components of normal language and communication, but a growing body of recent work documents the importance of an intact right hemisphere for narrative-level linguistic performance, e.g. understanding stories, jokes, and utterances in context [2–4, 9, 10, 11, 14, 15, 17, 22, 24–26]. Similarly, work with normal populations (using lateralized stimulus presentation), as well as research with clinical populations, points to a role for the right hemisphere in processing single words and concepts [6–8, 12, 16, 28, 29].

A full understanding of these broad domains of language (lexical-semantics and narrative), requires specification of each hemisphere's contributions to linguistic ability. In this paper, we examine the role of the right and left hemispheres in a particular domain of lexical-semantics: appreciation of metaphoric meanings of polysemous adjectives.

Most neuropsychological work on metaphor appreciation has focused on familiar phrases that can be interpreted either literally or figuratively, such as "The man has a heavy

---

||Address for correspondence: Hiram Brownell, Psychology Service (116 B), V. A. Medical Center, 150 S. Huntington Ave., Boston, MA 02130, U.S.A.

heart." For example, using a sentence–picture matching paradigm, WINNER and GARDNER [27] found that right hemisphere damaged (RHD) patients performed poorly while left hemisphere damaged (LHD) aphasic patients did relatively well [see also 21]. Similarly, MYERS and LINEBAUGH [19] have reported that RHD patients are deficient in understanding common idioms such as "face the music" [23]. Thus, RHD patients in general seem drawn to the literal meaning of stimuli and fail to appreciate the alternative, metaphoric interpretations. Whether or not these abnormalities in interpreting phrasal stimuli reflect specifically lexical-semantic deficits cannot be determined on the basis of these studies, but the frozen quality of the over-learned stimuli used suggests that these phrases could be stored as unanalysed units in the lexicon [18].

Brownell *et al.* [5] recently extended the neuropsychological investigation of metaphoric sensitivity to single words. These authors examined RHD and LHD patients' use of different aspects of words' meanings when asked to judge relatedness among a set of common adjectives: "warm", "loving", "cold", "hateful", "deep", "wise", "shallow", and "foolish". The method of triads was used: subjects were presented with all possible triads of words and, for each triad, were asked to pick the two words that were most related. One semantic relation was based on the metaphoric alternative meanings of adjectives. The dominant or most frequent meaning of "warm", for example, refers to the physical dimension of temperature. The metaphoric meaning, "loving", represents an extension of the literal meaning (or part thereof) to a different semantic domain, that of personality traits typically applied to humans. Another type of semantic relation relevant to this set of words was based on antonymic links, e.g., that between "wise" and "foolish" and between "deep" and "shallow". Analysis of subjects' responses revealed that nonbrain-damaged control subjects based their relatedness judgements primarily on antonym association and on metaphoric equivalance. RHD patients showed normal use of antonymic association, but less than normal use of metaphoric equivalence. LHD patients showed the opposite pattern; their results revealed a normal use of metaphoric equivalence but a decreased use of antonymic relatedness.

These contrasting patterns show that when asked to assess semantic relatedness, RHD and LHD patients focus on complementary meaning components of the same words. These patterns cannot easily be attributed to differences in how patients represent or process different parts of speech or entire classes of lexical entries such as abstract vs concrete words. Rather, the different response patterns more likely represent divergent processing strategies or abilities in the two patient groups.

The BROWNELL *et al.* study [5] clearly extends the right hemisphere metaphor deficit to single words, but leaves unanswered several questions concerning the precise nature and scope of the impairment. One hypothesis is that the reported metaphor deficit is indeed specific to metaphor and thus reflects problems restricted to metaphoric processing.

An alternative hypothesis is that the observed deficit reflects a pervasive inability of RHD patients to access or deploy any secondary, less frequent component of word meaning. The lexical-semantic deficits of these patients may not be restricted to metaphor; rather, they may be but one reflection of a more pervasive impairment affecting appreciation of different types of alternative meanings. Furthermore, a deficit involving appreciation of all alternative word meanings would raise the possibility of a common account for RHD patients' lexical-semantic deficits and their problems in narrative-level tasks. That is, a truly pervasive inability to appreciate alternative interpretations of linguistic units would similarly limit patients understanding of potentially ambiguous sentences including joke punchlines and indirect requests such as "Can you speak more softly?" [2, 3, 10, 14, 26].

To evaluate these two accounts further and to probe the respective contributions of the left and right hemispheres to lexical-semantic processing, we contrasted RHD and LHD patients' performances with metaphoric and nonmetaphoric polysemous words. We selected as stimuli adjectives and nouns to accentuate the distinction between words that lend themselves to metaphoric interpretations and those that do not. The potentially metaphoric concepts used in the present study were adjectives such as those used in the previous BROWNELL *et al.* study [5]. The nonmetaphoric words were polysemous nouns such as "cabinet" (cupboard, advisors). Each word was associated with at least two alternative meanings, the more frequent of which will be called the primary meaning and the less frequent of which will be called the secondary meaning. On each trial, a subject saw a triad of words consisting of a target polysemous concept (e.g. "warm"), a synonym (e.g. "loving") of its secondary meaning, and a foil (e.g. "blanket") that was closely associated—but *not* synonymous—with the primary meaning of the target. An example of a nonmetaphoric, noun-based triad includes the target "suit", the synonym "trial", and the foil "tailor". The task was to pick the two words that were the most similar in meaning. Thus the correct answer would be selection of the target and its synonym. The empirical questions of greatest interest were, one, whether the RHD patients would show a general deficit in appreciation of alternative word meanings, and, two, whether they would show a selective impairment by performing relatively worse on the metaphoric items than on the nonmetaphoric items.

METHOD

Subjects

Subjects included one ambidexterous and 33 right-handed adults under 70 years of age who had suffered unilateral brain damage due to stroke. With one exception in the RHD patient group, all patients were male. Lesion localization was based on the presence of clinical signs (e.g. hemiplegia, field cuts, sensory loss) and confirmed by CT scan in all but six cases. All patients were tested at least 2 months post onset of their illness. Of the 15 RHD patients, two had primarily anterior (pre-Rolandic) damage, four had primarily posterior (post-Rolandic) damage, and the remaining nine had mixed damage. The mean age of the RHD subjects was 61.5 years, and the mean number of years of formal education for the group was 11.9. Of the 19 LHD patients, all of whom were diagnosed as aphasic on the basis of the Boston Diagnostic Aphasia Examination [13], six had primarily anterior damage accompanied by nonfluent aphasia, eight had primarily posterior damage accompanied by fluent aphasia, and five had mixed damage. The mean age of the LHD patients was 59.8 years and the mean number of years of formal education was 12.3.

Testing was performed or attempted with additional subjects whose data will not be included in the major analyses described below. Testing was terminated prematurely for one RHD patient and three LHD patients who were unable to perform the task. Also, three other RHD patients (all of whom had mixed damage) gave ceiling-level performances defined as making two or fewer errors in both conditions. Data from these three RHD patients were excluded from statistical procedures except for one preliminary analysis noted below.

Also tested were a group of nine male and one female nonbrain-damaged control subjects of equivalent age and educational backgrounds as the brain-damaged patients. Because the control group's overall performance was close to ceiling level, data from these subjects will be discussed only briefly.

Stimuli

The stimulus set consisted of 16 metaphoric (adjective) and 16 nonmetaphoric (noun) word triads, each of which was printed on an index card. The three words in a triad were randomly ordered and printed one over the other in a vertical array. Each triad consisted of a target that could have at least two meanings, a synonym of the target's secondary (i.e. less frequent) meaning, and a foil related to the target's primary (i.e. more frequent meaning). The complete list of triads is presented as an Appendix. The 16 polysemous noun targets were selected from Perfetti, Lindsey and Garson's "Association and Uncertainty: Norms of Association to Ambiguous Words" [20]. Although many of the polysemous nouns could be interpreted as verbs, the verb sense was never selected as a primary or secondary meaning.

Both the metaphoric adjective and non-metaphoric noun targets were selected to include variation in the semantic similarity of their alternative meanings. A group of 10 pilot subjects (personnel of the Aphasia Research Center) rated the semantic similarity or relatedness between the alternative meanings for each of the 32 target words.

The two alternative meanings for each target were presented in appropriate sentential contexts. For example, the two context sentences for the noun target "page" were: "He only reads the front page of the newspaper" vs "The congressman's page went downstairs to get the coffee". The subjects received the following instructions: "Please rate how similar or how close the two meanings of each word are, as used in the sentences on the 3 × 5 cards. Use a rating scale of 1–7, 1 being synonymous and 7 being unrelated." Mean relatedness scores were calculated for each target and are presented in the Appendix. For both the metaphoric adjective triads (range: 2.4–5.7, mean = 4.3, SD = 0.8) and the nonmetaphoric, polysemous noun triads (range: 4.1–7.0, mean = 6.3, SD = 0.8), the alternative meanings of a target were sometimes closely related (e.g. "quick": fast vs smart) and sometimes unrelated (e.g. "suit" garment vs trial).

The (metaphoric) adjective and (nonmetaphoric) noun targets were also selected to include variation in the discrepancy between the relative frequencies of their primary and secondary meanings. PERFETTI *et al.* list the relative frequency of the use for the alternative meanings of each noun target. As shown in the Appendix, the difference in frequency for the alternative meanings is small for some noun targets (e.g. "board"), while large for others (e.g. "page"). Because no published norms were available to us for the adjective targets, subjective ratings were obtained for the relative frequency of use of adjective targets' alternative meanings and also, for purposes of comparison, the noun targets' alternative meanings. The same 10 pilot subjects described above were presented with the same 64 context sentences and instructed as follows: "Please rate how frequently you think the meaning of each word is used using a scale of 1–7, 1 being most frequently and 7 being infrequently. Please refer to the sentences on the 3 × 5 cards for an example of the usage of each word meaning." The variation in relative frequency of the primary and secondary meanings will not be discussed further since we found no reliable relation between patients' performances and relative frequency as indexed by either PERFETTI *et al.*'s norms or our own ratings. As can be seen in the relative dominance values listed in the Appendix there was poor agreement between the two measures for the noun targets ($r = +0.22$, ns).

The (metaphoric) adjective and (nonmetaphoric) noun triads were comparable in the degree of relatedness between each target and its literal associate. Twelve Aphasia Research Center personnel rated the relatedness between each target and its literal associate on a scale from 1 to 7, with low numbers indicating a high degree of relatedness. The mean ratings were very close for the adjective (mean = 1.8, SD = 0.64) and noun (mean = 2.0, SD = 0.51) targets.

Procedure

Subjects were tested individually in 30 min sessions. Only one subject needed two sessions to complete the task. Subjects received the following instructions: "I am going to show you a card with three words on it. I will read the words aloud while you read them to yourself. I then want you to choose the two words most similar in meaning—the two words which mean almost the same thing." The instructions were followed by three practice trials. Feedback was given on the three practice trials but not on any of the regular trials. The cards were reshuffled before each session so that a different random order of trials, including both noun and adjective items in a single list, was used for each subject.

RESULTS

For each trial, the correct answer was defined as selection of the target word and the synonym of its secondary or nondominant meaning. The dependent measure used in the first analyses reported below consisted of the number of correct answers a patient produced out of a possible 16 for each condition. It was extremely rare that subjects selected the foil and nondominant meaning as being the most similar in meaning. Only one control subject made one such nonsensical response. Two RHD patients made on such error each. Fourteen LHD patients made one such error each. Two LHD patients responded this way on four and on six trials, respectively. The small number of these errors demonstrates that all subjects in all groups understood the task and were not responding at random. Subsequent analyses will be based on the number of correct responses made by a subject in each of the two conditions.

One general result is that the RHD patients, as well as the LHD patients, performed more poorly than the control subjects in both metaphoric adjective and the nonmetaphoric noun condition. The LHD, aphasic patients' impaired performance in this language task is not particularly informative; however, the generally poor performance by the nonaphasic, RHD patients suggests a general deficit in appreciation of alternative meanings that extends beyond nonliteral interpretations of words and phrases to include homonymous nouns whose secondary meanings are not metaphoric. Parametric statistical tests were not appropriate to assess the difference between the RHD patients and the control subjects. Because the task was too easy for the control group, which artificially limited the variability across these subjects' scores, separate χ^2 tests were performed for the metaphoric adjective and nonmetaphoric noun conditions. For each test, a median split (above, below the median number of correct responses) and subject group (control subjects, RHD patients) were used as the two criteria for classification. Both χ^2 values (incorporating a correction for discontinuity in one degree of freedom χ^2 tests) were significant: $\chi^2_{(1)} = 7.62$, $P < 0.01$ for the noun condition, and $\chi^2_{(1)} = 6.18$, $P < 0.025$ for the adjective condition.

The purpose of the subsequent data analysis was to assess the relative diffculty of the two conditions for different subject groups. For this reason, the data from the nonbrain-damaged control group (six of whom scored at ceiling levels defined as fewer than two errors in either condition) and from the three patients who scored at ceiling level will not be included in the analyses that follow. Average performances for the remaining patients are shown in the far right-hand column of Table 1.

Table. 1. Mean number of correct responses for patients grouped by site of damage within each hemisphere

	Aphasic LHD patients		
	Anterior ($n = 6$)	Posterior ($n = 8$)	Total LHD patients ($n = 19$)
Metaphoric adjectives	7.7 (SD = 2.3)	7.0 (SD = 2.7)	6.9 (SD = 2.4)
Nonmetaphoric nouns	7.8 (SD = 1.7)	7.0 (SD = 1.5)	7.1 (SD = 1.5)
	Nonaphasic RHD patients		
	Anterior ($n = 2$)	Posterior ($n = 4$)	Total RHD patients ($n = 15$)
Metaphoric adjective	3.5 (SD = 0.7)	3.8 (SD = 3.1)	5.8 (SD = 3.8)
Nonmetaphoric nouns	5.0 (SD = 1.4)	8.5 (SD = 3.5)	8.2 (SD = 3.4)

One major result was that the 15 RHD patients who did not perform at ceiling levels were selectively impaired in their appreciation of metaphoric alternative meanings (mean = 5.8 correct, SD = 3.8) relative to nonmetaphoric alternative meanings (mean = 8.2, SD = 3.4). The LHD patients, in contrast, did not show the same marked difference between the metaphoric (mean = 6.9, SD = 2.4) and nonmetaphoric (mean = 7.1, SD = 1.5) conditions. An unweighted means, mixed-design analysis of variance (ANOVA) with site of damage (RHD, LHD) as the sole between-subjects factor and condition (metaphoric adjective, nonmetaphoric noun) as the sole repeated-measures factor revealed a reliable interaction of condition × site of damage, $F(1, 32) = 6.54$, $P < 0.025$. There was no reliable main effect due to site of damage, $F < 1.0$, but there was a reliable main effect of condition (metaphoric mean = 6.4, nonmetaphoric mean = 7.6), $F(1, 32) = 8.51$, $P < 0.01$.

In the above ANOVA, all RHD patients were placed in a single group and all LHD patients were placed in a single group to provide adequate sample sizes. We also examined the subset of patients in the present study who could be further classified by lesion site within each hemisphere into anterior and posterior subgroups. The resulting means, which are shown in Table 1, provide no support for a special role for either the right or left frontal lobes in appreciation of metaphoric alternative meanings. It should be emphasized, though, that this pattern of means is based on few patients and on a rather gross anatomical division. These means do not rule out the possibility of finer localization of function within the hemispheres.

Further confirmation that the RHD and LHD patients were responding in qualitatively different ways in this task is provided by an item analysis. This analysis revealed that the LHD patients but not the RHD patients were affected by the degree of semantic similarity between alternative meanings of metaphoric targets. These analyses collapsed across the different subjects in each group. That is, for each noun and adjective triad, the proportion of RHD patients answering correctly and the corresponding proportion of the LHD group answering correctly were calculated. Then, the rated semantic similarity between the primary and secondary meanings of the targets was correlated with performance separately for the LHD and RHD groups for the different types of targets. For metaphoric adjective targets, there was no reliable relation between performance and semantic similarity for the RHD patients, ($r = +0.33$, ns); in contrast, such a relation was found for the LHD patients ($r = -0.77$, $P < 0.001$). This last correlation indicates that the LHD patients did better when a target's alternative meanings were closely related. (Recall that lower ratings indicated greater relatedness.) There was no reliable relation between performance and similarity of alternative meanings of nonmetrophoric targets for either the LHD ($r = +0.38$, ns) or RHD ($r = +0.18$, ns) patients.

DISCUSSION

The results suggest a qualitative difference in the manner in which LHD and RHD patients process certain aspects of word meaning. Relative to LHD patients, RHD patients do not appreciate metaphoric meaning fully even at the single word level. This difference between the two patient groups cannot be attributed simply to a pervasive rigidity that prevents RHD patients from using any and all alternative meanings such as those carried by polysemous nouns.

The selective deficit of RHD patients suggests a role for the intact right hemisphere in the identification and evaluation of metaphoric meanings. Other effects in our data suggest, indirectly, that the metaphoric analysis normally performed by the right hemisphere is easier when the literal and metaphoric meaning of a word are closely related. This interpretation is based on the significant relatedness effect contained in the LHD patients' reponses to metaphoric adjective triads: alternative meanings that were more similar were easier for these patients with intact right hemispheres. LHD patients' sensitivity to relatedness may also figure in this group's better performance (relative to that of the RHD patients) in the adjective condition. Recall that the alternative meanings of the metaphoric adjective targets were on average more closely related than those of the nonmetaphoric noun targets. If LHD patients are more sensitive to semantic relatedness effects than RHD patients, then one would expect relatively better performance by LHD patients on the adjective triads.

LHD patients' peformance on the nonmetaphoric trials did not vary significantly as a function of relatedness. The line of reasoning presented above suggests that an intact right hemisphere contributes something different to the evaluation of alternative meanings that are not identified as metaphoric extensions of words' primary meanings. The present results do not speak to just what this contribution might be.

Another general issue concerns the possible link between the RHD patients' lexical-semantic deficits and their narrative level communication deficits. The present study provides some evidence for a pervasive insensitivity to all alternative meanings. With the exception of the three patients who scored at ceiling levels, the RHD group's impaired performance in the nonmetaphoric noun condition as well in the metaphoric adjective condition supports the existence of just such a pervasive dysfunction limiting interpretation of both literal and more figurative alternative meanings. (See [7] for a more detailed statement of this possibility.)

This research leaves unanswered several questions. One such question is whether these results will generalize to samples including larger proportions of female subjects. Another is whether the distinction between conditions will generalize to new sets of analogous stimulus items. Finally, in the present study, the metaphoric-nonmetaphoric distinction was perfectly correlated with the adjective-noun distinction. We have chosen to discuss our results in terms of metaphoric vs nonmetaphoric meaning on the basis of previous work. One source of support is our earlier study [5] which showed similar differences between LHD and RHD patients using just adjectives. Also generally consistent with this approach is work by Zaidel [29] on the lexical-semantic abilities of intact, but isolated cerebral hemispheres of split-brain patients. Zaidel reported that both hemispheres are better at processing nouns than adjectives, although the noun advantage for the right hemisphere was greater for words presented visually than auditorily. These sets of results make it unlikely that the part of speech distinction between nouns and adjectives can account for the results presented above. Still, a direct comparison between these two competing distinctions (adjective–noun, metaphoric–nonmetaphoric) would be a useful topic for future research. In any event, the major results of the present study reinforce the existence of differences in lexical-semantic analysis carried out by patients with unilateral lesions in the two hemispheres. Furthermore, these results support the view that both hemispheres make contributions to normal lexical-semantic processing.

Acknowledgements—This research was supported by NIH grants NS 11408 and NS 06209, the Research Service of the Veterans Administration, and Harvard Project Zero. We thank William Milberg, Christine Chiarello, and two anonymous reviewers for comments on an earlier draft, and we are grateful to Nancy Lefkowitz, Director of Speech and Language Pathology, and other personnel of the Spaulding Rehabilitation Hospital for their help and support in the conduct of this research. Portions of this work were reported at the Academy of Aphasia, October 1985, Pittsburgh, Pennsylvania.

REFERENCES

1. Benson, D. F. Aphasia. In *Clinical Neuropsychology*, 2nd Edition, K. M. Heilman and E. Valenstein (Editors), pp. 17–47. Oxford University Press, New York, 1985.
2. Bihrle, A. M., Brownell, H. H., Powelson, J. A. and Gardner, H. Comprehension of humorous and non-humorous materials by left and right brain-damaged patients. *Brain Cognit.* **5,** 399–411, 1986.
3. Brownell, H. H., Michel, D., Powelson, J. and Gardner, H. Surprise but not coherence: Sensitivity to verbal humor in right-hemisphere patients. *Brain Lang.* **18,** 20–27, 1983.
4. Brownell, H. H., Potter, H. H., Bihrle, A. M. and Gardner, H. Inference deficits in right brain-damaged patients. *Brain Lang.* **27,** 310–321, 1986.
5. Brownell, H. H., Potter, H. H., Michelow, D. and Gardner, H. Sensitivity to lexical denotation and connotation in brain damaged patients: A double dissociation? *Brain Lang.* **22,** 253–265, 1984.
6. Burgess, C. and Simpson, G. B. Cerebral hemispheric mechanisms in the retrieval of ambiguous word meanings. *Brain Lang.* **33,** 86–103, 1988.
7. Chiarello, C. Semantic priming in the intact brain: Separate roles for the right and left hemispheres? In *Right Hemisphere Contributions to Lexical Semantics*, C. Chiarello (Editor), pp. 59–69. Springer-Verlag, Heidelberg, 1988.
8. Cronin-Golomb, A. Comprehension of abstract concepts in right and left hemispheres of complete commissurotomy subjects. *Neuropsychologia* **24,** 881–887, 1986.

9. DELIS, D., WAPNER, W., GARDNER, H. and MOSES, J. The contribution of the right hemisphere to the organization of paragraphs. *Cortex* **19**, 43–50, 1983.
10. FOLDI, N. S. Appreciation of pragmatic interpretation of indirect commands: Comparison of right and left brain-damaged patients. *Brain Lang.* **31**, 88–108, 1987.
11. GARDNER, H., BROWNELL, H. H., WAPNER, W. and MICHELOW, D. Missing the point: The role of the right hemisphere in the processing of complex linguistic materials. In *Cognitive Processing in the Right Hemisphere*, E. PERECMAN (Editor), pp. 169–191. Academic Press, New York, 1983.
12. GAZZANIGA, M. S. Right hemisphere language following commissurotomy: A twenty year perspective. *Am. Psychol.* **38**, 525–537, 1983.
13. GOODGLASS, H. and KAPLAN, E. *The Assessment of Aphasia and Related Disorders*, 2nd Edition. Lea & Febiger, Philadelphia, 1983.
14. HIRST, W., LEDOUX, J. and STEIN, S. Constraints on the processing of indirect speech acts: Evidence from aphasiology. *Brain Lang.* **23**, 26–33, 1984.
15. HUBER, W. and GLEBER, J. Linguistic and nonlinguistic processing of narratives in aphasia. *Brain Lang.* **16**, 1–18, 1982.
16. JOANETTE, Y. and GOULET, P. Criterion-specific reduction of verbal fluency in right brain-damaged right-handers. *Neuropsychologia* **24**, 875–879, 1986.
17. JOANETTE, Y., GOULET, P., SKA, B. and NESPOULOUS, J.-L. Informative content of narrative discourse in right brain-damaged right handers. *Brain Lang.* **29**, 81–105, 1986.
18. LYONS, J. *Semantics*, Vol. 2. Cambridge University Press, Cambridge, 1977.
19. MYERS, P. S. and LINEBAUGH, C. W. Comprehension of idiomatic expressions by right-hemisphere-damaged adults. In *Clinical Aphasiology: Conference Proceedings*, R. H. BROOKSHIRE (Editor), pp. 254–261. BRK Publishers, Minneapolis, 1981.
20. PERFETTI, C. A., LINDSEY, R. and GARSON, B. Association and uncertainty: Norms of associations to ambiguous words. *University of Pittsburgh Research and Development Center Technical Report*, 1971.
21. STACHOWIAK, F.-J., HUBER, W., POECK, K. and KERCHENSTEINER, M. Text comprehension in aphasia. *Brain Lang.* **4**, 177–195, 1977.
22. TOMPKINS, C. A. and MATEER, C. A. Right hemispheric appreciation of prosodic and linguistic indications of implicit attitude. *Brain Lang.* **24**, 185–203, 1985.
23. VAN LANCKER, D. R. and KEMPLER, D. Comprehension of familiar phrases by left- but not right-hemisphere damaged patients. *Brain Lang.* **32**, 265–277, 1987.
24. WEINSTEIN, E. A. and KAHN, R. *Denial of Illness: Symbolic and Physiological Aspects*. Charles C. Thomas, Springfield, IL, 1955.
25. WECHSLER, A. The effect of organic brain disease on recall of emotionally charged versus neutral texts. *Neurology* **23**, 130–135, 1973.
26. WEYLMAN, S. T., BROWNELL, H. H., ROMAN, M. and GARDNER, H. Appreciation of indirect requests by left and right brain-damaged patients: The effects of verbal context and conventionality of wording. *Brain Lang.* **36**, 580–591, 1989.
27. WINNER, E. and GARDNER, H. The comprehension of metaphor in brain-damaged patients. *Brain* **100**, 719–727, 1977.
28. ZAIDEL, E. Language in the right hemisphere. In *The Dual Brain*, D. F. BENSON and E. ZAIDEL (Editors), pp. 205–231. Guilford Press, New York, 1985.
29. ZAIDEL, E. On multiple representations of the lexicon in the brain—The case of the two hemispheres. In *Psychobiology of Language*, M. STUDDERT-KENNEDY (Editor), pp. 105–125. MIT Press, Cambridge, Mass., 1983.

APPENDIX: STIMULUS TRIADS

Target	Perfetti *et al.* frequency	Pilot frequency	Pilot relatedness*	Synonym	Foil
		Metaphoric adjectives			
(1) Deep	—	1.2	4.2	Wise	Lake
(2) Shallow	—	1.0	3.8	Foolish	Puddle
(3) Straight	—	3.1	4.4	Honest	Ruler
(4) Crooked	—	1.0	4.2	Deceitful	Path
(5) Bright	—	0.1	5.1	Smart	Light
(6) Dull	—	1.7	3.2	Stupid	Butter knife
(7) Quick	—	1.2	2.4	Smart	Horse
(8) Slow	—	1.7	3.5	Stupid	Barge
(9) Warm	—	2.1	4.9	Loving	Summer
(10) Cold	—	1.2	4.3	Hateful	Winter
(11) Up	—	2.6	4.9	Happy	Arrow
(12) Down	—	1.8	5.7	Sad	Elevator
(13) Sweet	—	0.8	4.4	Nice	Candy
(14) Sour	—	2.2	4.1	Mean	Lemon
(15) Warm	—	1.8	4.9	Affectionate	Blanket
(16) Cool	—	2.4	4.9	Unfriendly	Breeze
		Non-metaphoric nouns			
(17) Suit	9	1.2	7.0	Trial	Tailor
(18) Deed	46	1.9	6.3	Act	Realtor
(19) Account	22	1.6	4.1	Explanation	Withdrawal
(20) Coach	29	2.8	6.2	Carriage	Athletes
(21) Board	9	0.4	6.7	Committee	Sandpaper
(22) Volume	34	1.8	6.5	Book	Stereo
(23) Kid	36	4.6	5.6	Goat	Schoolhouse
(24) tip	42	0.7	5.2	Edge	Waitress
(25) Pupil	39	0.3	6.9	Student	Eye
(26) Pen	12	2.7	7.0	Cage	Eraser
(27) Page	45	3.8	6.8	Attendant	Typewriter
(28) Arms	28	0.8	6.8	Weapons	Sleeves
(29) Club	45	1.7	6.9	Instrument	Caveman
(30) cabinet	21	2.2	6.7	Advisors	Dishes
(31) Letter	8	0.3	6.0	Symbol	Signature
(32) Case	44	0.6	6.8	Container	Lawyer

*Lower relatedness values indicate greater semantic similarity.